

Undergraduate Research Experience in Ocean/Marine Science (URE-OMS)

Dr. Linda B. Hayden
Campus Box 672 ECSU
1704 Weeksville Road
Elizabeth City, NC 27909
phone: (252) 335-3696 fax: (252) 335-3790 email: lhayden@umfort.cs.ecsu.edu

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LONG-TERM GOALS

The URE-Ocean/Marine Science program supports active research participation by undergraduate students in remote sensing and GIS. The program is based on a model for undergraduate research programs supported by the National Science Foundation. URE project features mentors, research projects, and professional development opportunities. It is the long-term goal of the URE in Ocean/Marine Science to provide an active research experience as an effective way to attract talented undergraduates and retain them in careers in ocean and marine science.

OBJECTIVES

The program objective is to promote the professional development of underrepresented undergraduate students through their participation in ongoing ocean and marine science research. During the summer programs, research team investigations focused on remote sensing applications to ocean and marine science research.

APPROACH

Applications were accepted from throughout the country. Undergraduate students selected were citizens or permanent residents of the United States. Each student was assigned to a specific research team, where he/she worked closely with the faculty. In addition, seminars, lunch meetings, and social functions were organized to facilitate interaction. The project was conducted for six weeks during summer 2001 and eight weeks during summer 2002 and 2003, with on-line mentoring and follow-up during the academic year. Each student was granted a stipend of \$300 per week, housing and in some cases assistance with travel. Students who are in those groups traditionally underrepresented in science (women and members of under-represented minorities) were particularly urged to apply.

The Program Timeline was as follows:

Spring: Development of the website and fliers to advertise the program and selection of 10 participants.

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Summer: Conduct 8 weeks of training in Ocean and Marine Science, 1 visiting lecture, opening and closing programs; Publish student projects on the web and in print form.

Following Academic Year: On-line mentoring of students by faculty and advise students on applying for future summer Ocean and Marine Science internships.

WORK COMPLETED

A total of nine research teams were formed during the 2001, 2002, and 2003 programs. Each team's abstract is given below. Team webpages are available at <http://nia.ecsu.edu/ureoms2002/teams.htm> and <http://nia.ecsu.edu/onr/ocean/teams.htm>.

Team #1: CoastWatch Remote Sensing Data Validation. CoastWatch is a National Oceanic and Atmospheric Administration (NOAA) program that provides remotely sensed satellite data to government decision-makers and academic researchers. CoastWatch data are used in a variety of ways including: monitoring sea surface temperatures, studying fish distribution, and aiding in ocean forecasting. The CoastWatch Validation Study team conducted research to determine the reliability and accuracy of CoastWatch. To conduct this study CoastWatch software, AVHRR datasets, and ground truthing were utilized. Multi-day composites of sea surface temperature maps were also created and analyzed. Those composites were then compared to data collected from various sources including buoys and the Field Research Facility in Duck, North Carolina.

Team #2: Science ARCVIEW/GIS Software as a Tool for Evaluating Coastal Populations. More than half the population lives on or near coasts, that's less than one-fifth of the land in the contiguous United States. Because of this large number, coastal area planners have to devise methods for gathering and analyzing information regarding populated areas.

The most effective tool for handling such a arduous task is the ARCVIEW/GIS. The spatial capabilities of ARCVIEW/GIS allows for consistent quality in its modeling features by way of producing digital maps with vector features produced using arcs, nodes, polygons, and label points. This in turn allowed us to interpret and understand the information that has been gathered by the area planners and processed by the GIS in a digital manner by the system. It also allows for estimations and future predictions of population. These benefits are nearly impossible to obtain using spreadsheets or other non-graphic methods of data organization. Once data were interpreted through ARCVIEW/GIS, it was taken out of and combined with other data to form correlations. This project investigates ARC/INFO techniques and tools that can be used to evaluate population number and growth in coastal areas. Correlations and patterns were investigated with regards to how the number of roads effect population in coastal areas.

Team #3: Validation of LITE Tropospheric and Stratospheric Measurement. The Lidar-In-Space-Technology-Experiment (LITE) was flown on the STS-64 in September of 1994. LITE was the first lidar developed to fly in Earth's orbit and perform atmospheric studies. The LITE mission had three major objectives: validate instruments for operational spaceborne lidars, explore as many applications of spaceborne lidars as possible, and gather information on the range and variability of cloud, aerosol, and surface return signals for use in designing future systems. LITE used a Nd:YAG laser operating at three channels (1064 nm, 532 nm, and 355 nm) to study Earth's lower atmosphere.

This project used a single scatter lidar equation to investigate tropospheric and stratospheric aerosol and temperature measurements derived from the 355 and 532 nm channels. Temperature profiles of the 355 nm channel were compared to coincident balloonsonde measurements between 5 and 40km. The results were discussed. The 355 nm channel temperature profiles were corrected for aerosol scattering using the 532 nm channel and an assumed Angstrom coefficient. The RMS between the corrected profiles and the balloonsonde data were computed.

Team #4: Correlation of AVHRR SST with the Presence of Loggerhead Sea Turtles. The Mid-Atlantic serves as a host environment for a number of sea turtle species that encompasses their seasonal migration routes. Global evidence suggests that the migration routes are strongly influenced by two factors: sea surface temperature and chlorophyll-a concentrations.

Data gathered from the Pacific Ocean present compelling evidence of this relationship. In contrast, the findings from studies conducted in the Atlantic have not yet confirmed the role of these factors. Therefore this study attempted to establish a correlation between sea turtle locations in the Atlantic Ocean in relation to sea surface temperature. Satellite sensor data including the NOAA AVHRR instrument were utilized for this study in addition to WhaleNet point source turtle data.

Team #5: Fishery Stock Yield and Spawning Biomass Per Recruit Model. The project was designed through a joint effort between NOAA Northeast Fishery Services, Jackson State University, and Elizabeth City State University. The team evaluated the status of fish stock and predicted how the stock responded to exploitation and harvest activities. The team also presented multi-formula modeling utilizing the Ricker, Schaefer, and Von Bertalanffy formulas, age determination and yield-per-recruit and spawning biomass per recruit, and full age structure models.

The Fish Stock Assessment final project followed the Atlantic cod, one of the most valuable description of the fisheries that interact with the stock and the presentations of fishery-dependent data, results of research surveys that provide fishery-independent data on abundance and samples for biological analysis.

Team #6: Seasonal Changes in Phytoplankton Concentration Using MODIS Satellite Images. Ocean color data depend on the accurate measurement of light intensity at visible wavelengths of the surface waters. In the ocean, light is reflected primarily by particulate matter suspended in the water, while absorption is primarily due to the chlorophyll content, which is present in phytoplankton.

The concentration of phytoplankton from Cape Hatteras to Cape Cod was studied through the analysis of ocean color data. Data were analyzed using digital image processing software to quantify the phytoplankton distribution with changing seasons. Periodic ground truthing of the satellite data was accomplished by water sampling and analysis for the type and amount of phytoplankton using accepted analytical procedures. Collection of data and some water sampling took place both locally and onboard a NOAA Research Vessel for ground checking of satellite data.

Team #7: Satellite Observations of Surface Eddies in the North Atlantic Ocean. The global oceans are constantly affected by a wealth of dynamic natural processes. Recently, numerous oceanographic studies have revealed the existence of intriguing near-circular oceanic disturbances distributed worldwide and along ocean boundaries, characterized by long-lasting ocean height anomalies and, in some cases, abrupt sea surface temperature boundaries. This study utilized data for the detection and

understanding of the intrinsic physical and biological processes that occur at marine cyclonic centers in the Atlantic Ocean. Data from TOPEX/Poseidon, SeaWiFS, MODIS, AVHRR and QuikSCAT sensors were utilized.

Team #7: Bottlenose Dolphin Occurrence off the Virginia Coastline and its Relationship to Sea Surface Temperature. As one of the most intelligent marine animals in the world, the Bottlenose dolphin, *Tursiops truncatus*, dominates its environment by being the top-level predator. Protected under the Marine Mammal Protection Act (MMPA) the preservation of bottlenose dolphins has been a primary concern of the government, researchers, and dolphin enthusiasts alike. Over the years many scientists have dedicated their research to preserving dolphins, and devising better methods in trying to locate them. It has been suggested that dolphins migrate toward areas of high chlorophyll concentration and relatively warm temperatures on the Atlantic coast. One of the methods the Navy is hoping to utilize is remote sensing. In compliance with the MMPA and the Office of Naval Research (ONR), this study explored the presence of dolphins using sea surface temperature (SST) and chlorophyll data from April 2000 to October 2001 using the Advance Very High Resolution Radiometer (AVHRR). SST data from NOAA data station at Sewell's Point were used where temperature from AVHRR was not available. Field data were collected using the passive observation technique from small boat cruises on set transects. The voyages took place on the Elizabeth River in Norfolk, Virginia, from May 2000 to October 2001.

Team #8: Science, Settlement and Remote Sensing: Locating the Remains of the Lost Colony. In the world of science, technology, and national security, remote sensing technology has emerged as a primary tool for retrieving and interpreting geographical data. Our research project, "Science, Settlement and Remote Sensing," aimed to expand the application of remote sensing technology by answering the question: What happened to the "Lost Colony of Roanoke?" Our research took an interdisciplinary approach to this 400 year old question by drawing on a wide range of primary and secondary sources from history, geography, archaeology, and most importantly remote sensing technology. Challenging some of the key scholarly assumptions about the fate of the "Lost Colony," we argue that the remnants of the "Lost Colony" can be located in Northeast North Carolina. In particular, our research strongly suggests that final fate of the "Lost Colony" can be traced to Buck Ridge near Roanoke Island.

Team #9: Correlation Between Right Whale Distribution and Sea Surface Temperature. The survival of endangered species plays an important role in our environment. Right whales are highly endangered and are sometimes killed by boats or entanglement in fishing gear. We studied the relationship between right whales and sea surface temperature to see if it might be feasible to predict where the whales will be in order to alert boats. We used right whale sighting data from aerial surveys of water near Massachusetts, USA. Sea surface temperature data was collected from NOAA's AVHRR satellites. We were only able to find eight clear satellite images among the days with right whale sighting data. This allowed only minimal quantities analysis. Nevertheless, we believe that it might be possible with more data to predict right whale distribution using remote sensing.

RESULTS

The URE Program featured high quality interactions with faculty and/or other research mentors, structured research projects, and professional development opportunities.

Faculty research mentors and lecturers included:

Dr. Timothy Olsen, Univ. Wis.-Madison, Remote Sensing
Dr. Francisco San Juan, ECSU
Dr. Ali Omar, Hampton Univ., Atmospheric Science
Dr. Ambrose Jearld, Woods Hole, Massachusetts
Dr. William Porter, ECSU, Geosciences Dept.
Dr. Ambrose Jearld, Woods Hole, Massachusetts
Dr. Linda Hayden, ECSU, Math and Computer Science Dept.
Dr. Mike Fogary, Woods Hole, Massachusetts
Dr. Charles Sun, NOAA Coastal Oceans Laboratory
Dr. Paulinus Chigbu, Fisheries Stock Assessment

Professional Development opportunities included:

Field Research Facility at Duck, NC
IEEE IGARSS Annual Conference
Oceanography Training
Cape Hatteras Light House and Sand Dunes Tour
Woods Hole Plankton Gear Research Vessel Sailing, Albatross IV Vessel
National Marine Fisheries Service – Woods Hole

IMPACT/APPLICATIONS

The URE Ocean and Marine Science program has achieved national impact through its ability to enroll a significant number of non-ECSU students. A total of 40 students have participated in the URE programs including 19 institutions and 11 majors. Included among the institutions were the University of Hawaii, the University of Maryland-College Park, Dillard University, Morgan State, UNC-Pembroke, J.C. Smith, Hampton University, NOVA University and Bethune Cookman. Among the majors included were Physics, Computer Science, Marine Biology, Computer Engineering, Geography, Geology, Mathematics, and Agricultural Sciences. There has been a total of 26 males and 14 females including one Hispanic and one non-minority participating in the program. The largest percentage of participants were African-American.

RELATED PROJECTS

Correlation of AVHRR SST with the Presence of Sea Turtles (N00014-10-1-1070), provides technical support and remote sensing capabilities. <http://nia.ecsu.edu/ureoms2002/teams.htm>.

NASA – Network Resource and Training Site (NCC5-00533), provides a consortium of HBCU/MI institutions from which undergraduate students are recruited. <http://nia.ecsu.edu/>.

PUBLICATIONS

[1] Hayden, Linda, 2003, *Undergraduate Research Experience in Ocean, Marine and Space Science*, IGARSS 2001 Proceedings, Toulouse, France.

[2] Hayden, Linda, 2001, *You Be the Scientist with Satellite Imagery in EZ/EC Communities*, IGARSS 2001 Proceedings, Sydney, Australia.

[3] Harrison, Keisha, 2003, *Correlation of AVHRR SST with the Presence of Loggerhead Sea Turtles*, IGARSS 2003 Proceedings, Toulouse, France.

[4] Harrison, Keisha, 2001, *Innovative Visualization of Geospatial Data for Transportation Engineering Applications*, IGARSS 2001, Sydney, Australia.

HONORS/AWARDS/PRIZES

Dr. Linda B. Hayden, Elizabeth City State University, “Women of Color in Research Sciences and Technology”, U.S. Black Engineers Magazine.